

Bait Shrimp Research Studies Performed at the Waddell Mariculture Center

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Opportunity

In South Carolina, the availability of wild Atlantic white shrimp is seasonal and the shrimp fishery is closed December 16th to April 30th.

South Carolina bait dealers and recreational fishermen rely on pink shrimp imported from Florida much of the year.

The live bait shrimp market is huge. Between 65-75% of the approximately 14 million recreational saltwater fishermen use live bait shrimp.

Recreational saltwater fishermen, contribute over \$34 billion to the nation's economy. In South Carolina, the economic impact of recreational saltwater fishing is nearly \$1 billion.



BAGGED D.E.
10lb - \$22
20lb - \$4

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Marketing and Production Advantages for a Cultured Bait Shrimp Product

Bait shrimp are sold wholesale for \$80 - \$125 per thousand; retail for \$3.50 – \$4.25 per dozen.

There is no consistent year-round source of bait shrimp in SC.

Atlantic white shrimp are cold-water tolerant.

When Atlantic white shrimp are stocked in intensive production systems, they will remain an acceptable bait size longer because of slow growth rates.

Fishermen prefer 4 to 6 grams size shrimp.

Bait shrimp production studies were performed at the Waddell Mariculture Center in Bluffton, SC.



Ponds

Could ponds be stocked and effectively managed for bait shrimp production in South Carolina?

The state has approximately 40,000 hectares of manageable saltwater impoundments and ponds.

If bait shrimp perform well in ponds, existing facilities could be used to reduce production costs.

Harvest would be seasonal. When exposed to winter water temperatures, Atlantic white shrimp bury into pond sediments and could not be lured to “bait” for capture.

Could shrimp be harvested efficiently and transported to bait dealers without loss?

Pond Live Bait Shrimp Production Study

Atlantic White Shrimp

Pond size:	.10 hectare
Stocking rate:	24,000 pl-26, Scientific Associates, Inc.
Stocked:	June 30 th
Water temperature	32 °C during stocking
Aeration:	1 hp mechanical paddlewheel aerator
Water management:	2% daily exchange rate for evaporation
Diet:	Zeigler Bros, Inc. HI-35 fed twice daily



First harvest on grow-out day 40

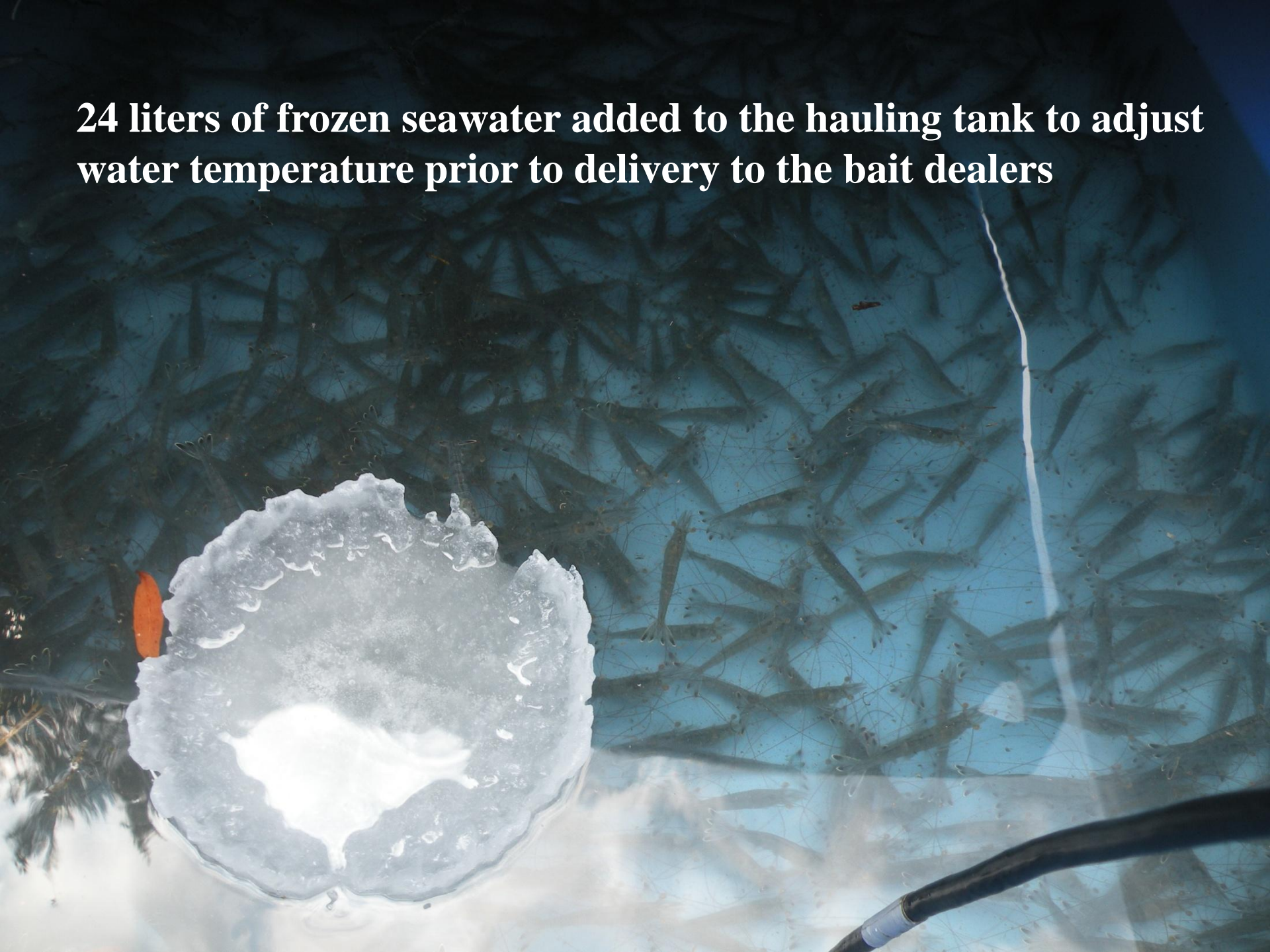
hauling box filled with .5 m³ of seawater

1.8 meter
cast net





24 liters of frozen seawater added to the hauling tank to adjust water temperature prior to delivery to the bait dealers





CONTROLLED
ENVIRONMENT



Pond Harvest Data

Mean pond harvest data: 3 August 9th – 16th G.O. day: 40 - 47

Salinity: 32.9g/l Water temperature :29.9 °C Cooled to 25.7 °C

Dissolved oxygen: 12.8 mg/l

1050 shrimp captured 9 throws - 117/cast net Mortality: 4

Shrimp size: 5.72 grams

Time: 2 hours from harvest to delivery (acclimation)

Bait dealer tanks: Salinity: 31.7g/l Water temperature :24.5 °C

Dissolved oxygen: 6.22 mg/l

Results

Two bait dealers reported an estimated mortality rate of nearly 80% three days after stocking.

They also reported comparable losses after receiving shipments of local wild Atlantic white shrimp.

To determine if the high mortality rates at the bait shops were caused by the shrimp raised in the ponds, two additional shrimp pond harvests were performed. The same harvest procedures were followed. The shrimp were stocked into two 2.0 m³ tanks at the WMC. Unusually high mortality rates of at least 80% were observed by G.O. day 3.

Pond shrimp and wild shrimp samples from both bait dealers were collected and sent to Don Lightner at University of Arizona. The shrimp tested positive for *Vibrio*.

Indoor Shrimp Bait Production

Are indoor closed systems better suited for year-round bait shrimp production?

What are the optimum nursery stocking rates?

How well do Atlantic shrimp perform in cold-water and is there density effect?

How well do Atlantic white shrimp perform in warm clearwater and biofloc managed tanks.

Optimum Stocking Density for Atlantic White Shrimp Nurseries

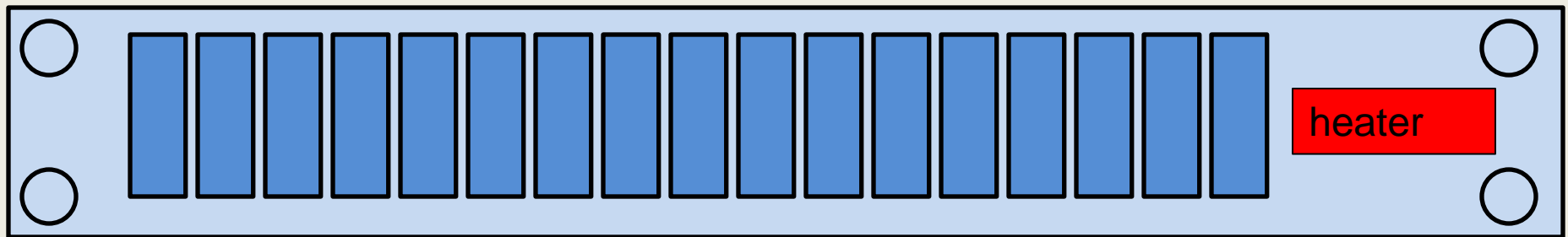
Bait shrimp growout systems will have a two phase production component that includes a nursery to head-start postlarvae.

To determine maximum stocking levels for a nursery, a density regression study was performed.

Atlantic white shrimp postlarvae were stocked into seventeen 60 liter glass aquariums.

Atlantic white shrimp nursery stocking density

- Seventeen 60-L aquaria
- Circulating water bath – heater & 4 directional air lifts



Stocking densities = 400m^3 to 2800m^3 in $150/\text{m}^3$ increments

PL- 18, Mean size: .011 g.

G.O time: 36 days

Results

Figure 2. Survival (%) as a Function of Post Larvae Stocking Density

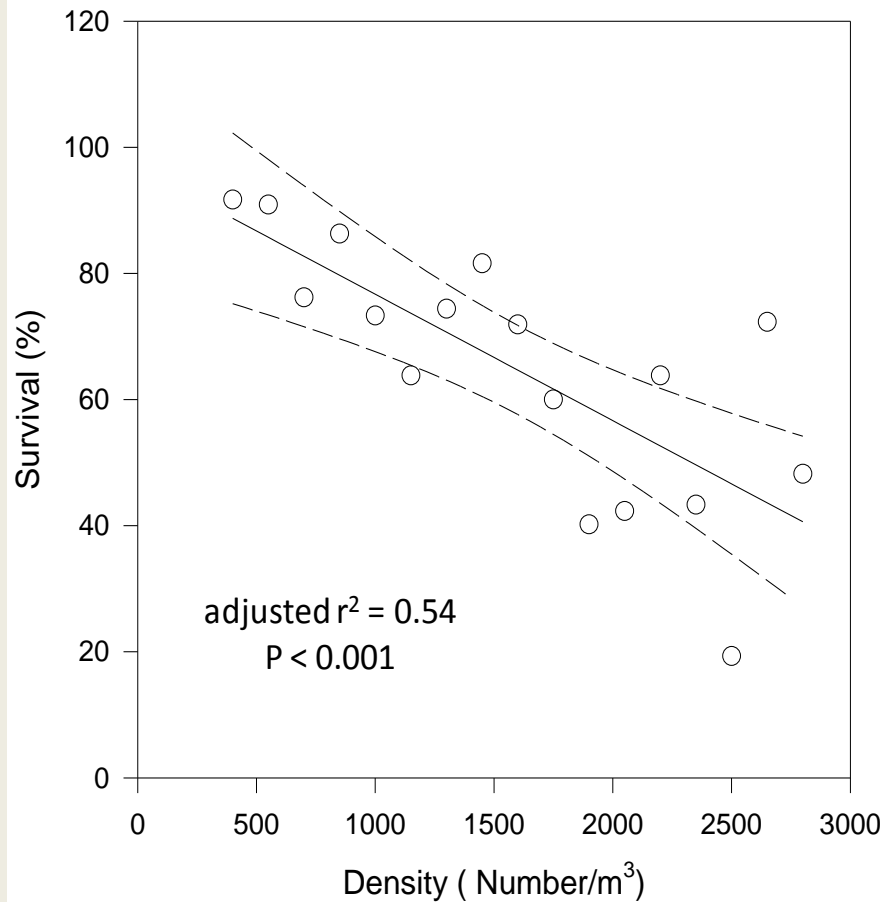
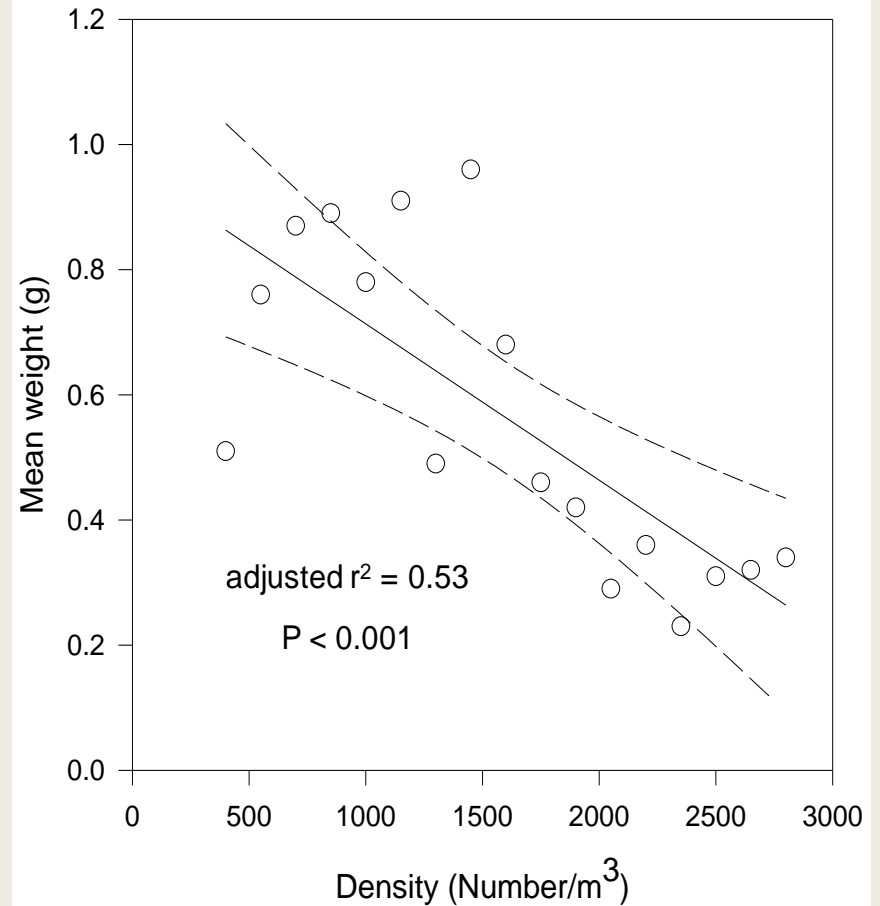
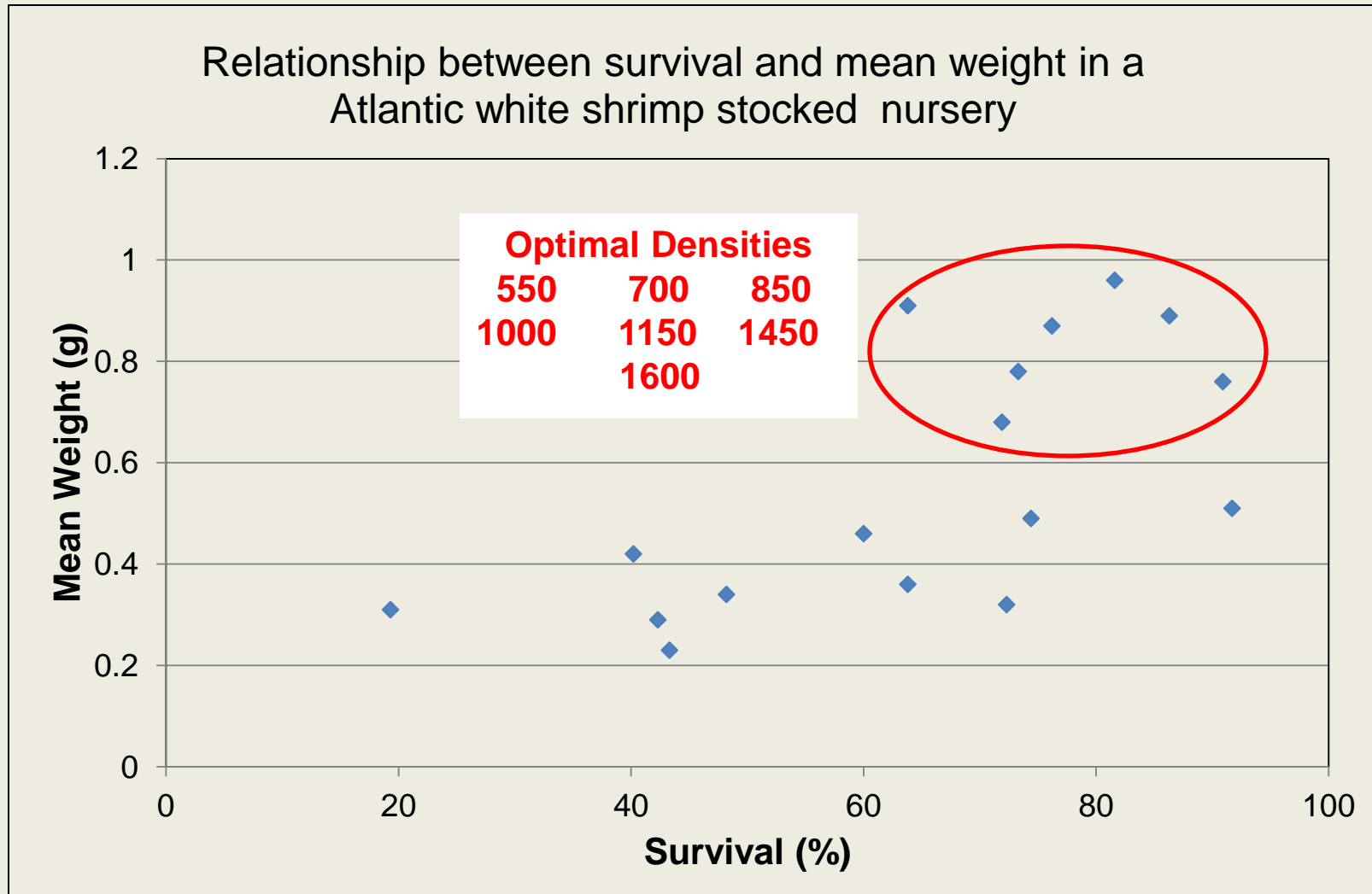


Figure 3. Mean Harvest Weight as a Function of Post Larvae Stocking Density



Results



Performance of Atlantic White Shrimp in Non-heated Winter Clearwater Managed Systems

Atlantic white shrimp can be found as far north as New York and has a reputation of being cold water tolerant. If Atlantic white shrimp could be grown without heating the water, it would be a significant operating cost savings.

Performance of Atlantic White Shrimp in Non-heated Winter Clearwater Managed Systems

Treatment	Reps	Stocking Rate	Tank size
Clearwater	2	300 shrimp/m ³	2.0 m ³
	2	200 shrimp/m ³	2.0 m ³
	2	100 shrimp/m ³	2.0 m ³

Mean stocking size: .33 g

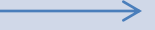
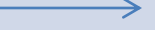
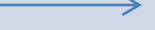
Mean Temp: 17.9 C

Temp Range: 13.6 - 21.7 C

Growout days: 71



Performance of Atlantic White Shrimp in Non-heated Winter Clearwater Managed Systems

Treatment	Mean Harvest Size (g)	Growth (g/week)	Survival (%)	FCR
100 shrimp/m ³ Mean	.33  .85	.052	96	4.25
Range	.80 & .90		94 & 98	4.00 – 4.50
200 shrimp/m ³ Mean	.33  .80	.047	90	6.85
Range	.80 & .80		84 & 96	6.70 – 7.00
300 shrimp/m ³ Mean	.33  .70	.037	86	9.75
Range	.70 & .70		80 & 91	11.30 – 8.20

Results

For all three stocking densities of 100, 200, and 300 shrimp stocked per cubic meter, growth was less than .5 gram in 71 days. Survival was very good and averaged 91%.

Increasing stocking density appeared to have an effect on shrimp growth and survival performance .

Atlantic white shrimp grow very little in seawater temperatures averaging 17.9 C.



Performance of Atlantic White Shrimp in Heated Clearwater and Biofloc Managed Systems

Treatment	Reps	Stocking Rate	Tank size
Clearwater	3	300 shrimp/m ³	2.0 m ³
Biofloc	3	300 shrimp/m ³	2.0 m ³

Mean stocking size: .33 g

Mean Temp: 26.4 °C

Temp Range: 21.2 - 28.6 °C

Growout days: 71

Heated Biofloc vs Heated Clearwater Systems



biofloc



clearwater flow-through

Heated Clearwater vs. Heated Biofloc

300 shrimp/m³

Treatments/ Reps		Stocking (g)	Harvest (g)	Survival (%)	FCR
Clear	1	.33	3.6	65.6	2.5
Clear	1	.33	3.1	69.4	2.8
Clear	1	.33	3.2	70.7	2.7
Clear	Mean	.33	3.3	68.6	2.7
Biofloc	1	.33	4.7	45.5	2.9
Biofloc	2	.33	3.9	65.6	2.3
Biofloc	3	.33	4.4	42.8	3.3
Biofloc	Mean	.33	4.3	51.3	2.8

Results

Survival tended to be better in Clear-water, but not significantly different ($P = 0.079$).

Mean growth rate was significantly greater in the biofloc treatment ($P = 0.021$).

Size variability among individual shrimp ($P = 0.033$) and among replicate tanks ($SD = 0.404$ vs 0.265) was much greater for biofloc than clear-water.

(an inherent disadvantage?)

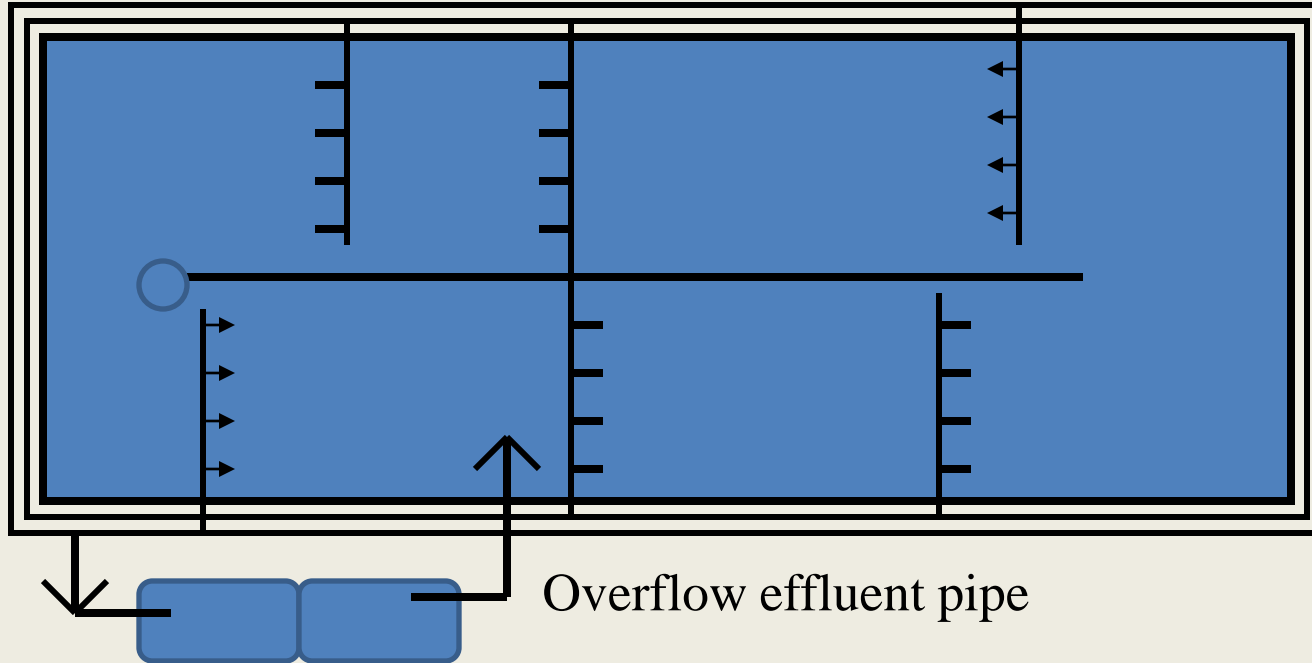
Producing Atlantic White Shrimp in a Biofloc Managed Closed System

A covered raceway, 13.4 m³, was stocked with nursery reared 0.51 gram juvenile Atlantic white shrimp at a density of 222 shrimp/m³.

The raceway had been setup adjacent to the center's commercial size greenhouse raceway stocked with *L. vannamei*. Pipes were installed to connect the two raceways together so the raceway and tank could share the same biofloc managed water supply generated primarily in the larger 235 m³ size raceway.

Bait shrimp production setup

235 m³ greenhouse covered raceway stocked with *L. vannamei*



Biofloc managed water supply pumped through the bait shrimp raceway at an exchange rate of 160%/day

Overflow effluent pipe

13.4 m³ raceway stocked with *L. setiferus* at 222 shrimp/m³





Biofloc managed water supply

The bait production raceway received a water exchange rate of 160%/day from the larger raceway. Both raceways were operated with no new water.

The Atlantic white shrimp were fed by hand a Zeigler Bros. HI-35 shrimp growout diet two times per day.

Production was terminated on growout day 92. Loss of electrical power caused nearly 30% of the shrimp to die due to low dissolved oxygen levels. All shrimp were immediately harvested and counted to determine the survival rate prior to day 92.

Survival: 81.3%

Mean harvest size: 4.3 grams



Growth was slow and would appear to be caused by a combination of high stocking density and the inability to maintain optimum growth temperatures in the bait shrimp raceway.

Temperature range: 16.6 to 25.9 degrees C.

Mean growth: 0.29 g/week

Summary

Atlantic white shrimp can be grown in nurseries stocked at 550 to 1600m³.

Indoor closed biofloc based production systems appear to be better suited for year-round Atlantic bait shrimp production. Pond production appears to be limited to seasonal harvests and there are potential disease problems to consider.

Cold water and high stocking densities affects growth rates.

Shrimp perform best in heated biofloc based systems when compared to clearwater managed systems.

Nursery reared Atlantic white shrimp (.5g) reared in heated biofloc based managed closed systems can reach market size in less than 100 days (4 – 6g).

No unusual mortality occurred when bait shrimp were harvested from any of the closed indoor production system studies and transported to bait shops.

